

Reconfigurable Transmission Line for a Series-Fed Ku-Band Phased Array Using a Single Feed

Nicholas K. Host, Chi-Chih Chen, John L. Volakis

Electrical and Computer Engineering
The Ohio State University
Columbus, OH, USA

Félix A. Miranda

Antenna and Optical Systems Branch
NASA John H. Glenn Research Center
Cleveland, OH, USA

Abstract—The paper presents a novel approach to realize a low-cost phased array using a simple feeding mechanism. Specifically, a single coplanar stripline (CPS) transmission line is used to feed the antenna array elements. By controlling the CPS's dielectric properties using a movable dielectric plunger, scanning is achieved. Due to its simplicity, single feed, and no phase shifters, this approach leads to a dramatic reduction in cost which does not scale for larger arrays.

I. INTRODUCTION

Phased array systems are preferred for beam scanning due to their increased agility over mechanically scanned systems. However, this greater capability comes at the expense of substantial cost [1]. The additional cost is due to the many feeds and associated phase shifters. Techniques, such as array thinning [2] and sub-arraying [3], have been proposed for cost reduction. But, these approaches lead to degraded pattern performance. Alternatively, leaky-wave antennas have been proposed, but these require magnetic materials [4] or realize scanning by changing the operational frequency. To reduce cost and retain fabrication simplicity, in this paper we propose a reconfigurable transmission line for a series-fed array. The transmission line is of the coplanar stripline type, and by changing the dielectric constant of this inner gap, its propagation constant is modified to achieve scanning. A movable dielectric plunger is used for controlling the propagation constant. A major challenge with this design is its practical realization in the Ku-band without a need to retain extreme parameter control. This paper introduces a CPS design allowing dielectric constant control without the need to keep extreme tolerances.

II. TRANSMISSION LINE DESIGN

The proposed transmission line is comprised of a coplanar stripline with a movable dielectric insert positioned between the two strips as seen in Figure 1. This insert is mechanically moved up and down, leading to controllable change of the propagation constant as depicted in Figure 2. In turn, modification of the propagation constant, as determined by the dielectric to air ratio within the gap, induces scanning. Practical and low cost realization of the gap control is of great importance in this design.

Our previous design achieved scanning down to $\pm 30^\circ$ using a gap value from $0.73\text{mils} < g < 9\text{mils}$, implying strict tolerances [5]. The new design, given here, has a gap range of $30\text{mils} < g < 100\text{mils}$, implying much greater control of the beam without a requirement for extreme tolerances.

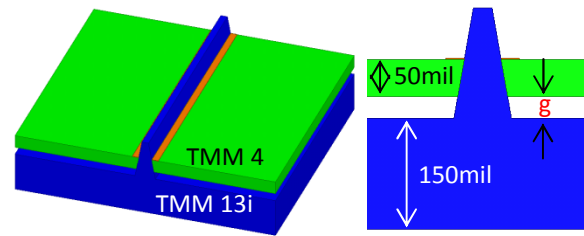


Fig. 1: CPS transmission line.

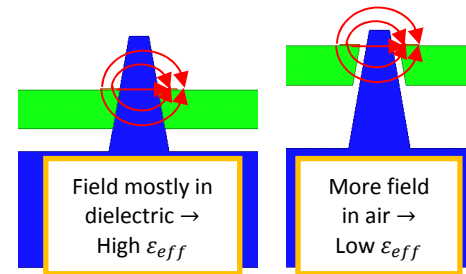


Fig. 2: Plunger to control CPS propagation constant.

III. CONCLUSION

A novel reconfigurable transmission line feeding a series-fed array was proposed. By controlling a single mechanical parameter of the transmission line, its propagation constant is controlled, leading to beam scanning. In addition to using a single feed, other advantages of this approach are low cost and simplicity.

REFERENCES

- [1] D. J. Carlson, C. Weigand, and T. Boles, "MMIC Based Phased Radar T/R Modules," pp. 455-458, Proceedings of the 7th European Radar Conference, 30 September -1 October Paris, France.
- [2] R.L. Haupt, J.J. Menozzi, and C.J. McCormack, "Thinned arrays using genetic algorithms," IEEE Int. Symposium on *Antennas and Propagation*, AP-S. Digest, Vol. 2 no., pp.712-715, 1993
- [3] H. Schrank and H. Schuman, "Antenna Designer's Notebook-design curves for reducing the number of phase shifters in-phased arrays by subarraying," IEEE *Antennas and Propagation Magazine*, Vol.35 (2), pp.56-58, 1993
- [4] N. Apaydin, L. Zhang, K. Sertel, J.L. Volakis, "Nonreciprocal and magnetically scanned leaky-wave antenna using coupled microstrip lines," IEEE Int. Symposium on *Antennas and Propagation*, July 2011
- [5] N. Host, C-C. Chen, J. Volakis, and F. Miranda, "Novel Phase Array Scanning Using Single Feed Without Using Individual Phase Shifters," 34th Annual Symposium of the Antenna measurement Techniques Association, Oct. 21-26, Bellevue, WA.